REMARKS

Applicants respectfully request reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow. This amendment adds, changes and/or deletes claims in this application. A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, is presented, with an appropriate defined status identifier.

After amending the claims as set forth above, claims 1-5 and 7-11, 13, 16-28 are now pending in this application. Claims 12 and 14-15 were canceled because their limitations were added to the independent claims from which they depended. New claims 26-28 were added. Support for this claim may be found, for example, on page 9 of the specification. No new matter was added.

In addition to the remarks and amendments provided in an Amendment After Final Rejection filed March 7, 2003 and entered with the RCE filed on August 5, 2003, applicants respectfully request the examiner to consider the following remarks.

Applicants respectfully request that suspension of action requested in the RCE transmittal filed August 5, 2003 be stopped as of the filing date of the present Amendment and that the next Office Action be issued in due course.

I. The prior art rejections should be withdrawn

Independent claim 20 was rejected under § 103(a) as being unpatentable over Watari (USP No. 5,922,145), Shibata (USP No. 4,773,947) or Eguchi (USP No. 5,746,842) in view of the Annealing of Steel Textbook ("Annealing Textbook"). Independent claims 1, 4, 5 and 7 were rejected under § 103(a) as being unpatentable over Eguchi in view of the Annealing Textbook. Dependent claims were rejected under § 103(a) over Eguchi and Annealing Textbook alone or further in view of additional references. These rejections are respectfully traversed.

A. The pending claims

The present application contains independent claims 1, 4, 5, 7 and 20, which were previously amended to recite a spheroidizing heat treatment of original claim 6. Claims 1, 4, 5, 7 and 20 recite a low carbon machine structural steel comprising carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in an amount of not less than 0.4 % by weight, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight.

During the claimed heat treatment for spheroidizing, carbide is precipitated and contained in the machine structural steel. The carbide has an average particle size of not larger than 1 μm and the maximum particle size of not larger than 3 μm. The heat treatment for spheroidizing includes maintaining said machine structural steel at a temperature ranging from 700 to 820 °C, and cooling said machine structural steel to a temperature of 600 °C at a cooling rate of not higher than 20 °C per one hour.

B. Differences between the claims and Eguchi

First, the production process of the steel according to the claimed process and its differences from Eguchi's process will be discussed.

(a) First, a raw material (i.e., steel) is provided. The raw material may be subjected to melting, rolling or the like, if desired.

(b) Then a pre-heat treatment for spheroidizing is performed. This pre-heat treatment precipitates carbide in the steel. The results of this heat treatment are illustrated in the cross-sectional microphotograph of Fig. 1 in the present application. In contrast, Eguchi does teach or suggest such a heat treatment.

(c) Then, a machining (such as cutting) step is performed. The steel of claim 4 corresponds to a product formed at this step. Claim 7 recites performing this step. Claims 26-28 recite that this step is performed after the spheroidizing heat treatment. Evaluation tests in Figs. 3 and 4 of the present application are made on the steel formed at this step.

(d) A post machining heat treatment (hardening, tempering or the like) may then be performed. Thus, after the claimed steel is machined, it is subjected to a post machining heat treatment, as recited in claim 7 for example. If desired, the heat treated steel is then subjected to further machining, such as cutting, grinding or the like, and/or inspection to form the final product. It is believed that Eguchi's heat treatment shown in Fig. 3 of Eguchi corresponds to this post machining heat treatment. After this heat treatment step, the final texture and hardness of the product are set.

Applicants note that as recited in claims 7 and 26-28, the pre-heat treatment for spheroidizing in step (b) is conducted in order to facilitate the machining of step of (c). By carrying out the heat treatment for spheroidizing under the process conditions recited in claims 1, 4, 5, 7 and 20, the improved and unexpected cutting force and tool wear amount results illustrated by lines L2 and L4 in Figs. 3 and 4 of the present application are obtained. If the pre-heat treatment is carried out under conditions different from those recited in claims 1, 4, 5, 7 and 20, then the cutting force or resistance (force required for cutting) becomes large as indicated by the line L1 in Fig. 3 of the present application while the tool life is shortened as indicated by the line L3 in Fig. 4 of the present application.

These results described on pages 11 and 12 of the present application indicate that the properties of the steel differ significantly based on the conditions of the annealing. These results are unexpected from the teaching of Eguchi because Eguchi does not teach or suggest a heat treatment for spheroidizing, but instead teaches a post-machining heat treatment, which is conducted at a different point in the process. Thus, Eguchi fails to teach the combination of a low carbon steel and the pre-heat treatment for spheroidizing. Thus, Eguchi's steel cannot be expected to provide the unexpected advantages achieved by the claimed steel and method.

C. Differences between the claims and the Annealing of Steel textbook

1. No motivation to combine

The office action asserts that the spheroidizing heat treatment is disclosed in "Annealing of Steel" textbook. However, there is no motivation to use the spheroidizing heat treatment of the textbook in a low carbon steel of Eguchi.

The Annealing of Steel textbook discloses on page 47, middle column, that "Low-carbon steels are seldom spheroidized for machining, because in the spheroidized condition they are excessively soft and "gummy," cutting with long, tough chips." This passage means that spheroidizing heat treatment (annealing) is seldom applied to a low carbon steel in order to obtain a good machinability.

The present inventors unexpectedly discovered that the claimed spheroidizing heat treatment (annealing), when applied to a low carbon steel, results in a high turning-machinability. Thus, applying the spheroidizing heat treatment to low carbon steel for the purpose of improving the machinability cannot be derived from the Annealing of Steel textbook because the textbook teaches away from this combination. Therefore, there is no motivation to combine Eguchi and the Annealing of Steel textbook. In addition, with respect to claim 20, there is no motivation to combine Watari or Shibata and the Annealing of Steel textbook.

2. The combination does not teach or suggest all claimed elements

Furthermore, even if there was motivation to combine Eguchi and the textbook, the combination would not teach or suggest all claimed limitations. The independent claims of the present application recite that the spheroidizing anneal is conducted at 700 to 820 C followed by the claimed cooling parameters.

In contrast, the middle paragraph on page 47 of the Annealing of Steel textbook states that 1020 steel may be spheroidized at 690 C after being cold drawn into a tubing. This page does not describe the cooling schedule. These parameters are different from those of the independent claims of the present application.

There is no other disclosure of the spheroidizing parameters for low carbon steels in the cited portion of the textbook. Table 4 of the Annealing of Steel textbook does not disclose the spheroidizing condition of low carbon steels. Thus, this textbook does not suggest to conduct the spheroidizing anneal for a low carbon steel at 700 to 820 C followed by the claimed cooling parameters, as recited in the independent claims.

Applicants submit that the heat treatment conditions for high carbon steels, such as steels containing 0.40 to 0.50 % carbon, is not necessarily the same as those for low carbon steels. For example, on page 46, second column, fourth full paragraph of the Annealing of Steel textbook, the spheroidizing process for a 1040 steel (a medium/high carbon steel containing about 0.37 to 0.44 % carbon) is explained as follows: "Cooling at a suitable rate from the minimum temperature at which all carbide is dissolved to prevent reformation of a carbide network, ... " This means that the purpose of annealing for medium and high carbon steel is to prevent once separated carbide (cementite) from reforming carbide network.

In contrast, the present inventors discovered that in the low carbon machine structural steel, a carbide precipitates under a heat treatment for spheroidizing. This limitation that a carbide is precipitated is recited in all pending independent claims. The purpose of the spheroidizing heat treatment in the claimed invention is to precipitate carbides, such as MC, M_2C, M_7C_3 and the like, in addition to prevention of formation of carbide network. Therefore, the spheroidizing heat treatment in the claimed invention is different in meaning from the annealing of the medium and high carbon steel described in Annealing of Steel textbook.

One or ordinary skill in the art would not necessarily use the spheroidizing parameters for high carbon steels used to prevent reformation of a carbide network to precipitate carbides in a low carbon steel. Thus, these parameters are not a matter of routine optimization.

3. Unexpected results

Neither Eguichi not the Annealing of Steel textbook teach that the spheroidizing anneal results in carbide precipitation. Eguchi does not even teach a spheroidizing anneal and

the cited portion of the Annealing of Steel textbook does not teach that the spheroidizing anneal results in carbide precipitation.

Thus, the claimed spheroidizing heat treatment of the claimed low carbon steel which results in carbide precipitation achieves an unexpected result compared to the disclosures of Eguchi and the textbook, because carbide precipitation during spheroidization is not expected from the disclosures of Eguchi and the textbook.

II. The § 112 rejections should be withdrawn

Independent claim 20 was rejected under § 112, ¶1 as being not enabled for the claimed silicon range, and under § 112, ¶2 as being indefinite for containing the term "relatively small amount." These rejections are respectfully traversed.

Claim 20 recites a relatively small amount of silicon not less than 0.4 wt %. As explained in the previous response, this claimed amount is commensurate in scope with the examples provided in the specification. Thus, this term is limited to a few percent silicon, but below 5 or 10 wt.% silicon suggested in the Office Action. Applicants submit that the specification enables the claimed silicon range because this claimed range is commensurate in scope with the present specification.

Furthermore, applicants submit that the term "relatively small amount" complies with § 112, ¶2 because one of ordinary skill on the art can ascertain the metes and bounds of this range. As discussed in the previous response, persons of ordinary skill in the art can recognize the effective amount of silicon that can be used in a steel to achieve desired results based on reading the present specification and the prior art. For example, the specific examples of the present specification illustrate that 1.23 wt.% silicon is a "relatively small amount." However, the upper range of silicon may also be a fraction of a percent higher depending on the other alloying elements in the steel. However, one of ordinary skill in the art can easily determine this range without undue experimentation.

III. Conclusion

Applicants believe that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested. The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

Respectfully submitted,

Date 8/20/03 By _____

FOLEY & LARDNER
Washington Harbour
3000 K Street, N.W., Suite 500
Washington, D.C. 20007-5143
Telephone: (202) 672-5300
Facsimile: (202) 672-5399

Leon Radomsky
Attorney for Applicant
Registration No. 43,445

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 19-0741.